No. 765,434. PATENTED JULY 19, 1904.

C. M. MANLY.

ROTARY PUMP OR MOTOR.

APPLICATION FILED OCT. 9, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

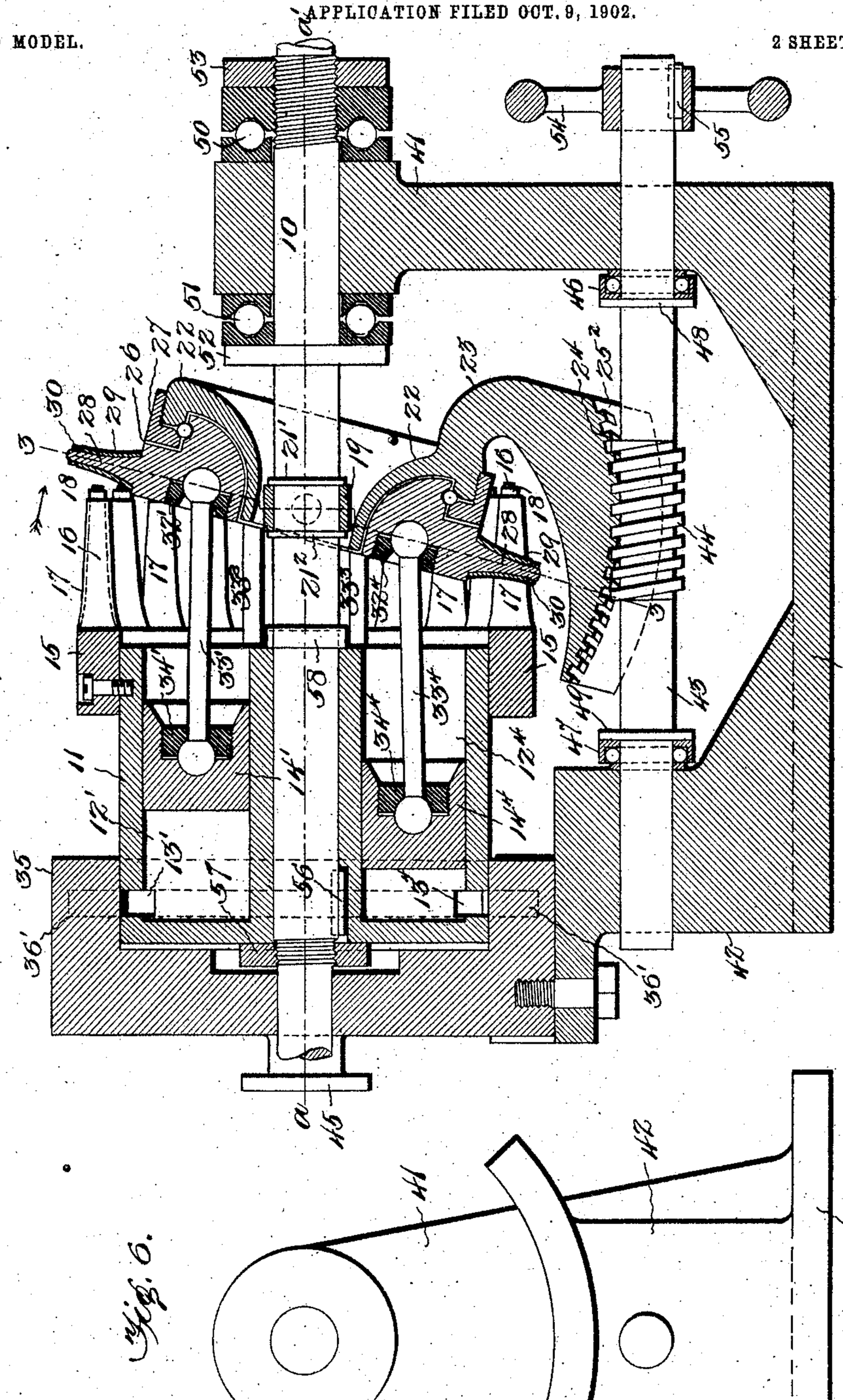

Fig. 6.

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

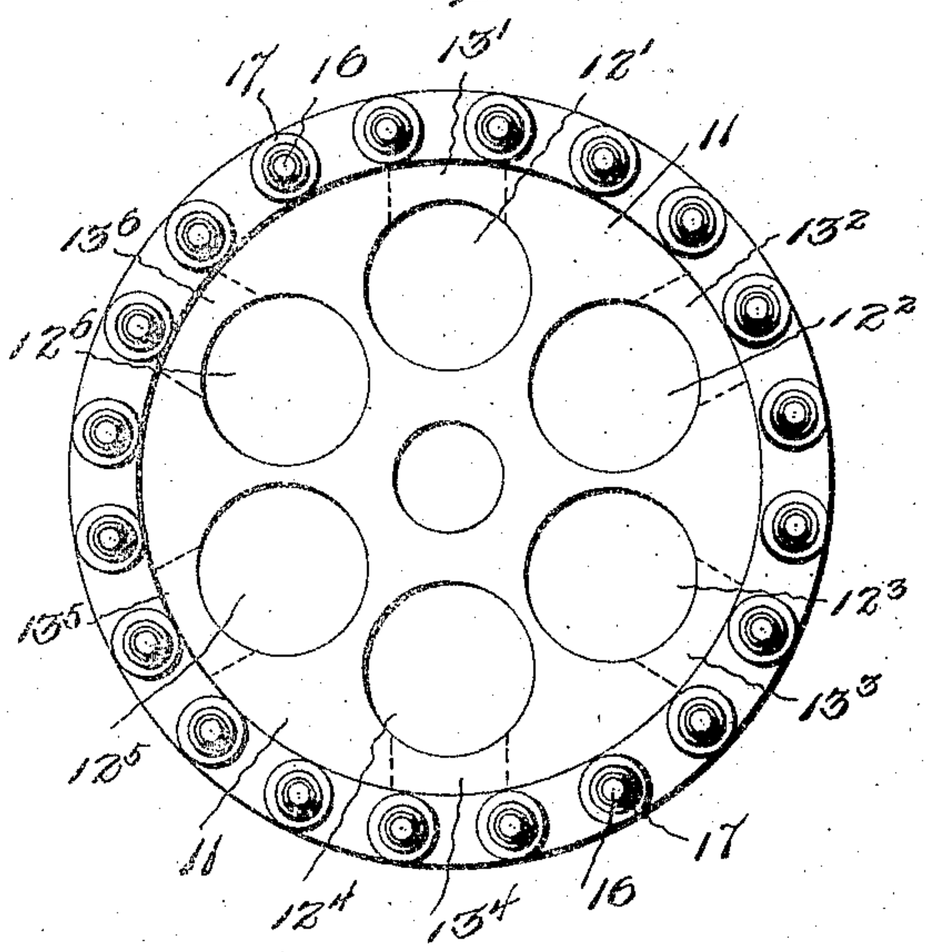


Fig. 3.

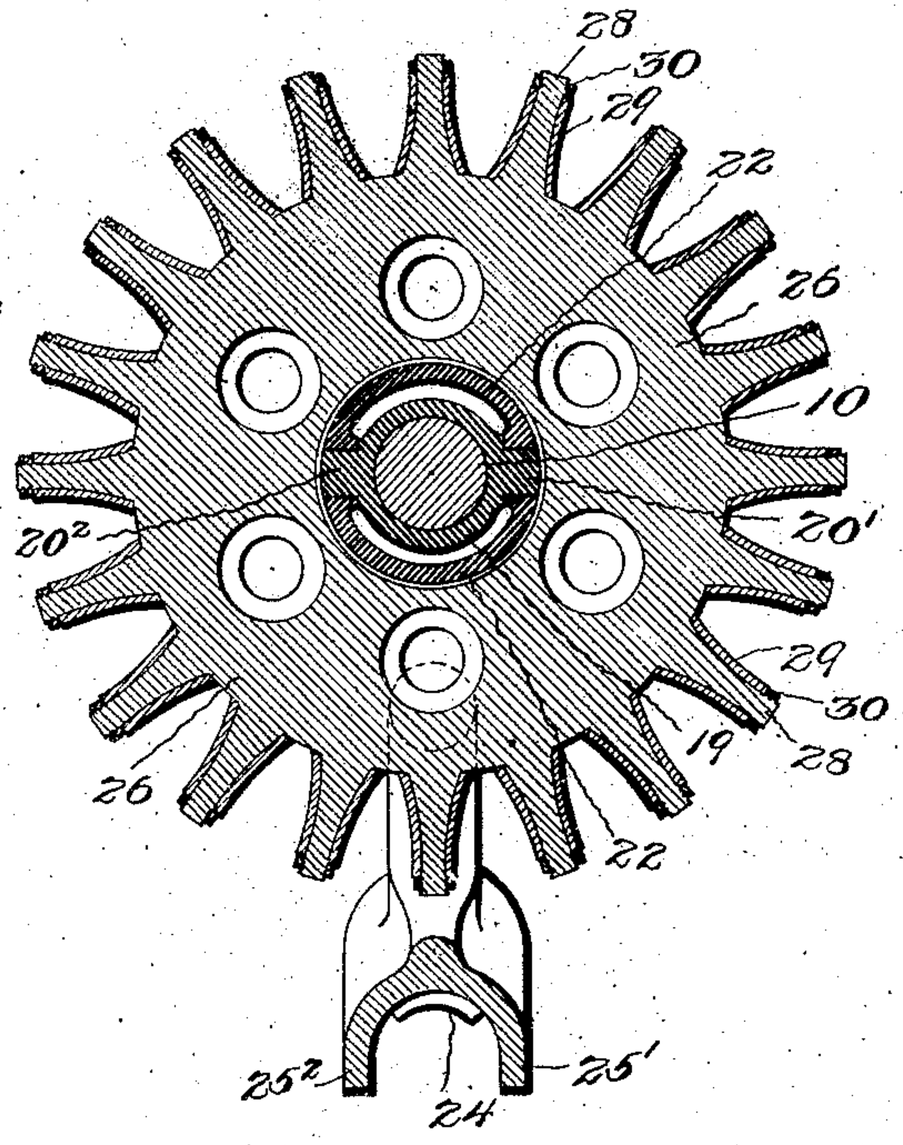


Fig. 5.

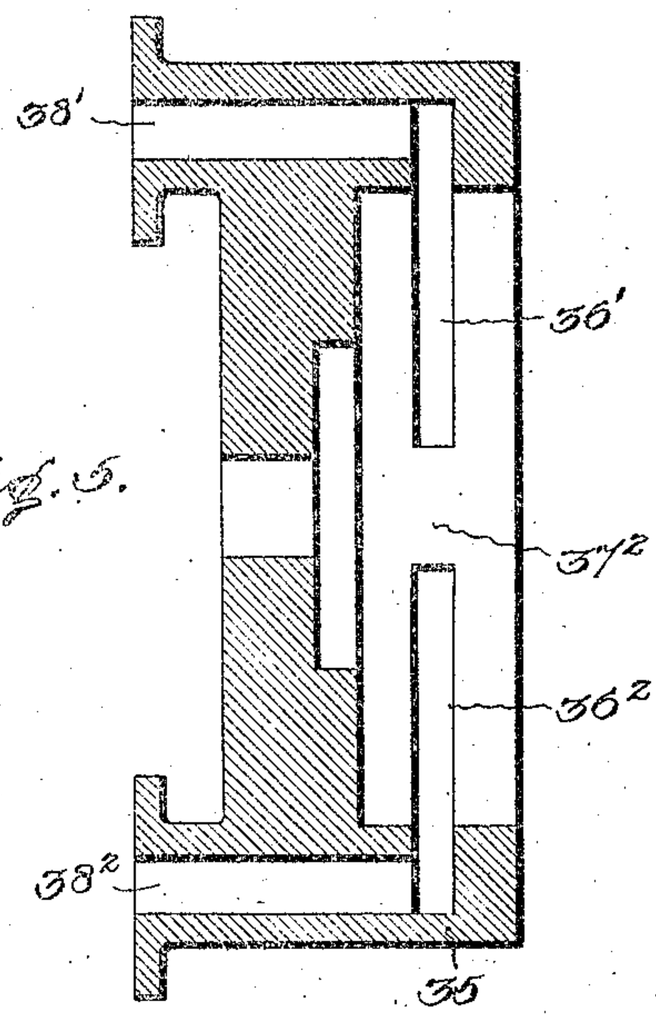
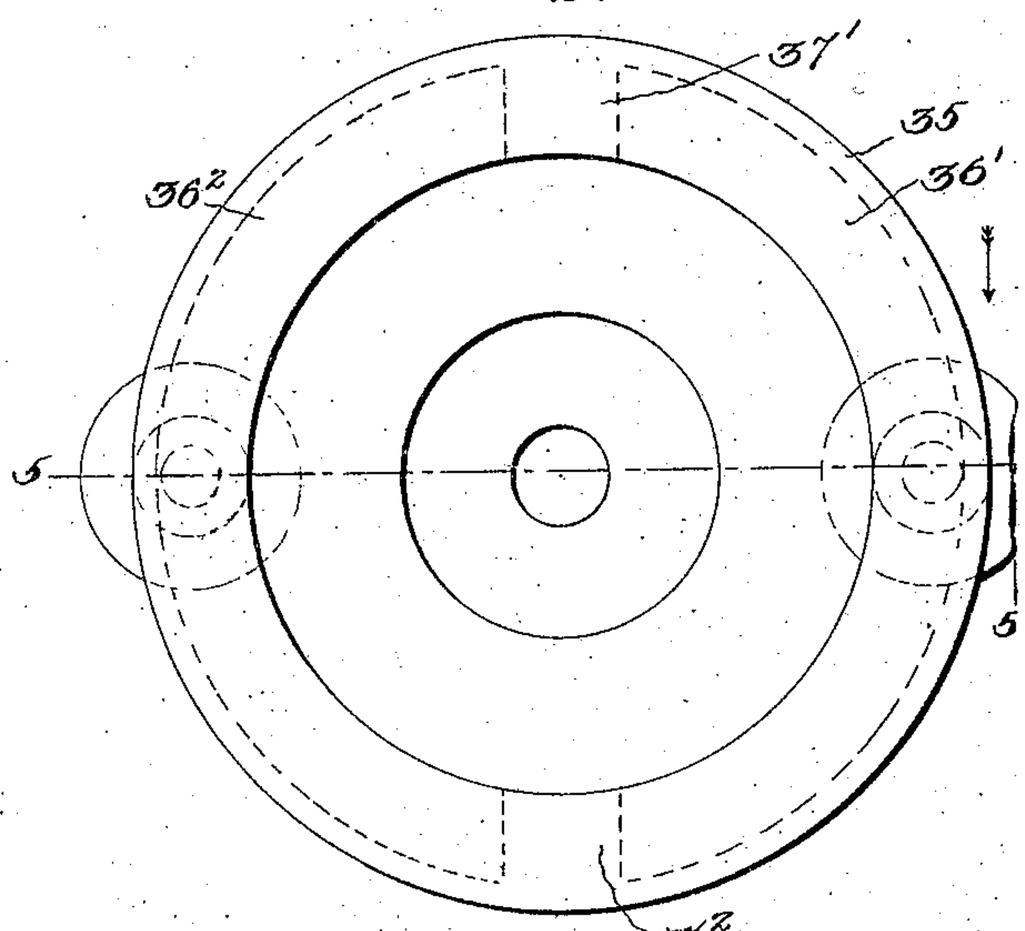


Fig. 4.



Witnesses
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No. 765,434. Patented July 19, 1904.

UNITED STATES PATENT OFFICE.

CHARLES M. MANLY, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO COOPER-HAMPTON ELECTRIC COMPANY, A CORPORATION OF MINNESOTA.

ROTARY PUMP OR MOTOR.

SPECIFICATION forming part of Letters Patent No. 765,434, dated July 19, 1904.

Application filed October 9, 1902. Serial No. 126,534. (No model.)

To all whom it may concern:

Be it known that I, CHARLES MATTHEWS MANLY, a citizen of the United States, and a resident of Washington, District of Columbia, have invented certain new and useful Improvements in Rotary Pumps or Motors, of which the following is a specification.

My invention relates to that class of rotary pumps or motors in which a series of cylinders arranged to revolve around a common axis are connected to a revoluble disk or head and in which the length of stroke of the pistons may be varied, thereby varying the quantity of fluid delivered or the amount of power produced without stopping said pump or motor.

My object is to provide simple and effective means in such mechanisms as that designated for adjusting the length of stroke of the pistons and at the same time to provide an apparatus which will operate with the least frictional loss, and particularly to improve pumps or motors of the type disclosed in Patent No. 511,044, granted December 19, 1893, to William Cooper and George P. Hampton.

With these objects in view my invention consists of a pump or motor comprised of a suitable supporting-framework, a series of cylinders arranged around a common axis to form a drum, a shaft journaled in said frame and connected to and supporting the drum containing the cylinders, pistons arranged in said cylinders, a thrust plate or ring to which the pistons in the said cylinders are connected and which is adapted to rotate in unison with said cylinders, a relatively fixed adjusting-ring mounted on said shaft, and having the thrust-plate to which the pistons are connected journaled in it, said adjusting-ring being non-rotary and adapted to be adjusted to assume any incline with respect to the shaft to increase or decrease the length of stroke of said pistons; and my invention further consists in the novel construction and details thereof, with reference to the accompanying drawings, as hereinafter described, and more particularly pointed out in the claims.

In the drawings, Figure 1 is a longitudinal sectional view through the center of my pump or motor. Fig. 2 is an end view of the drum containing the cylinders and looking toward the left in Fig. 1. Fig. 3 is a transverse sectional view on the broken line 3 3, Fig. 1, looking in the direction of the arrow. Fig. 4 is an end view of the receiving and distributing valve looking toward the left in Fig. 1. Fig. 5 is a section through the valve on the line 5 5, Fig. 4, looking in the direction of the arrow; and Fig. 6 is a detached end view of the supporting-frame and looking toward the right in Fig. 1.

Since the construction of my device is practically the same when used either as a pump or a motor, I will first describe it when in operation as a pump and, second, when in operation as a motor.

Referring now to the drawings, in which the same reference characters relate to the same or corresponding parts in all the views, 40 indicates a suitable framework, on which is fixedly mounted a stationary valve 35, provided with two semicircular ports $36'$ and 36^2, consisting of passages or channels cut in the inner face of the annular flange projecting from the web of the valve, said ports and constituent passages being separated from each other by the two bridges or partitions $37'$ and 37^2, diametrically disposed with reference to each other and here represented in a vertical plane, as shown in Figs. 1 and 4. Passing through the center of the valve structure 35 is a shaft 10, one end of which is journaled in said valve and the other end in a suitable standard or upright 41, projecting from or forming a part of the framework 40. Both ends of the shaft 10 extend beyond the uprights or standards, so that in the case of the pump power may be applied to either end of the shaft, and from either end in the case of the motor power may be delivered. Mounted on the shaft 10 is a drum or cylinder structure 11, which drum is fastened to the shaft 10 by a key 56 and the nut 57, which forces the drum against the shoulder 58 and has formed in it a plurality of cylindrical chambers $12'$ 12^2 12^3, &c., the bores of said cylindrical chambers being par-

allel with the axis of the shaft. The cylinders 12′ 12², &c., are provided with suitable ports 13′ 13², &c., respectively, adapted to register successively with the ports 36′ and 36² of the valve during the rotation of the cylinder structure. Pistons 14′ 14², &c., are slidably mounted in their respective cylinders and are connected to a thrust ring or plate 26 by means of the connecting-rods 33′ 33² 33³, &c, respectively, said thrust plate or ring being adapted to rotate in unison with said cylinders, and when the device operates as a pump is driven thereby. The thrust plate or ring 26 is journaled on the relatively fixed adjusting-ring 22, to which it is connected by a ball-bearing by means of a fastening-nut 27. The adjusting-ring 22 is supported by the shaft 10 through the medium of the supporting-ring 19, provided with projections or pivots 20′ and 20², on which projections the adjusting-ring 22 is pivoted. The supporting-ring 19 is not fastened to the shaft 10, but is journaled thereon, permitting the shaft to freely rotate in it, and the said supporting-ring 19 is prevented from slipping in an axial direction by the shoulders 21′ and 21² of the shaft 10, which overlap and bear against the ring 19. Mounted on the periphery and at the open end of the drum 11 is a ring 15, having a plurality of equidistant conically-shaped projections 16, on which are mounted conically-shaped bearing-sleeves 17, which are adapted to rotate on the said conical projections and which are prevented from slipping therefrom by the nuts 18. On the outer periphery of the thrust plate or ring 26 is a plurality of conically-shaped radial projections 28, having conically-shaped bearing-sleeves 29 mounted thereon, said bearing-sleeves 29 being prevented from slipping from said projections by means of the nuts 30. The conically-shaped projections 16, carried by the drum, are adapted to intermesh with the conically-shaped projections 28 on the thrust plate or ring, and thereby cause said thrust plate or ring 26 to revolve in unison with the cylinder-drum 11. The adjusting-ring 22, pivoted on the supporting-ring 19, which in turn is supported by the shaft 10, is provided with a projection 23, prolonged to form the sector of a worm-wheel 24, said prolongation extending on each side of the worm-gear teeth to form the guide-flanges 25′ and 25².

Rotatably mounted in the two standards 41 and 42 of the frame 40 is a worm-shaft 43, provided with a worm 44, which is adapted to mesh with the worm-wheel sector 24 of the adjusting-ring 22 and by means of which said adjusting-ring may be caused to turn on the pivots 20′ and 20² of the supporting-ring 19, thereby causing the adjusting-ring 22 to assume different inclinations to the axis of the shaft 10, which in turn causes the thrust plate or ring 26 to also assume these different inclinations to the axis, thereby causing a variation in the length of stroke of the pistons 14′ 14², &c., whose connecting-rods 33′ 33², &c., terminate in balls at each end, confined in socket-bearings in said pistons and thrust-plate and are secured thereto by the socket-nuts 34′ 34², &c., and 32′ 32², &c., respectively. The two guide-flanges 25′ and 25² of the sector worm-gear 24 are formed in such a manner as will allow the worm-screw 44 to freely turn between them, and at the same time they prevent the adjusting-ring 22 from rotating around the axis *a a′* by bearing against the sides of the worm-screw 44. The valve structure 35 is so placed that the two bridges 37′ and 37², which are made substantially equal in width to the width of the ports in the cylinders, are vertical, and the adjusting-ring 22 is also so placed that the worm 44, meshing with the sector-gear 24, causes said adjusting-ring to be adjusted in a vertical plane, thereby causing the pistons 14′ 14² 14³, &c., to arrive at the ends of their strokes at a time when the ports 13′ 13² 13³, &c., in the cylinder-chambers 12′ 12², &c., respectively, are being covered by the bridges 37′ and 37². In order to permit the ingress and egress of fluid through the semicircular ports 36′ and 36² of the valve structure, I provide two passages 38′ and 38², the passage 38′ being connected with the port 36′ and the passage 38² with the port 36², said ingress and egress passages being formed in the valve and projections therefrom terminating in suitable coupling-flanges, to which the supply and exit pipes may be connected. In order to provide for taking up the thrust which is produced on the worm-screw 44 by the pistons acting through their rods against the thrust-ring 26 and which is communicated to said worm through the adjusting-ring 22 and the sector worm-wheel 24, I arrange the thrust-bearings 46 and 47, which act between the flanges 48 and 49 on the worm-screw and the standards 41 and 42 of the frame, and in order to take up the thrust on the main driving-shaft 10 and provide against end play of the same, and thereby keep it in such a position that the ports 13′ 13², &c., of the cylinders preserve their proper longitudinal position with regard to the ports 36′ and 36² of the valve, I arrange thrust-bearings 50 and 51 on either side of the standard 41, said thrust-bearings acting against the nut 53 and the flange 52 on the shaft 10. Fastened to one end of the worm-screw shaft 43 is a hand-wheel 54, secured thereto by means of a key or feather 55, said hand-wheel forming a convenient means for turning the worm-screw shaft 43, and thereby causing adjustment of the adjusting-ring 22, which acting through the thrust-ring 26 and the connecting-rods 33′ 33², &c., cause adjustments of the length of stroke of the pistons 14′ 14², &c. However, it is to be understood that I do not confine myself to this particular method of ad-

justing the adjusting-ring 22, since it is evident that the same end may be accomplished by replacing the worm-wheel sector 24 and the worm-screw 44 with a spur-wheel sector and a rack having teeth meshing with the teeth of the spur-wheel sector or with any suitable mechanical movement.

The conically-shaped sleeves 29 and 17, mounted on the conically-shaped projections 28 and 16, respectively, provide a simple and effective means for lessening the friction between said projections, since these sleeves are free to rotate on their respective projections, and thereby prevent the slipping motion which would otherwise occur between the said projections on the ring attached to the drum and those on the thrust-ring, such a slipping motion being replaced by the rolling motion of the respective sleeves of the projections 28 of the thrust-plate on the respective sleeves 17 of the cylinder-ring 15. It will furthermore be noted that these projections 16 and projections 28 are so relatively shaped as not only to secure maximum strength, but more particularly to insure that the action between the conical sleeves will be so far as possible a pure rolling motion rather than a sliding or slipping motion and productive of excessive loss due to friction, as it otherwise would be, especially where the pressure between the two sets of projections is considerable, as in the present case. It should also be noted that I have arranged the valve so that the cylinders touch only the annular flange thereof, as such an arrangement avoids all the difficulty which is experienced in pumps or motors of this class, where the ends of the cylinders are open to form the cylinder-ports which act in connection with ports arranged in the face of the valve, this latter arrangement necessitating the bearing with considerable force of the end of the cylinder-drum against the face of said valve in order to prevent leakage of the fluid between said cylinder-drum and said valve-face, and, furthermore, the arrangement which I have shown avoids considerable difficulty which is experienced in pumps or motors of the type referred to, because of the tendency of the cylinder-drum to cant.

A pump or motor constructed in accordance with my invention as herein described, while applicable for general use as a pump or motor, is especially fitted for employment as an element or elements of fluid-pressure-operated variable-speed gears of the type shown, for example, in Patent No. 511,289 to Cooper and Hampton, dated December 19, 1893.

The operation of the device when used as a pump is as follows: Suppose the parts to be in the positions shown in Fig. 1, where the adjusting-ring is inclined at an angle to the shaft and the piston in cylinder $12'$ is at its outer dead-center, the piston in cylinder 12^4 is at its inner dead-center and the other pistons are at positions corresponding with the relative positions of their respective cylinders, and that the shaft 10 is rotated in a clockwise direction as viewed from that end which is at the right-hand side in Fig. 1. The cylinder-drum being fixed to the shaft will accordingly rotate with it and in so doing will carry the pistons and through the conically-shaped projections on the ring 15, meshing with the conically-shaped projections on the thrust-ring 26, will also cause the thrust-ring to rotate with it, and since the adjusting-ring is inclined at an angle to the shaft and the thrust-ring is free to rotate in the said adjusting-ring the said thrust-ring will be caused to revolve at said angle with the shaft, thereby causing the pistons to reciprocate in their respective cylinders, piston $14'$ moving toward the closed end of its cylinder, and thereby forcing any fluid therein out through the port $13'$ and into the port $36'$ of the valve, whence it is free to pass through the passage $38'$ and into any receptacle provided therefor. At the same time that the piston $14'$ moves toward the closed end of its cylinder the piston 14^4 moves toward the open end of its cylinder, and thereby tends to suck in through its port 13^4 any fluid which may be in the port 36^2 of the valve, and since said port 36^2 is connected to the passage 38^2 fluid from any receptacle which may be attached to said passage 38^2 will thereby have access to the cylinders which connect through their ports with the port 36^2 of the valve, the remaining cylinders operating in a similar manner and either sucking in or forcing out fluid, according to their relative positions. If now the rate of rotation of the shaft remain constant and it is desired to pump fluid at a faster rate, the adjusting-ring 22 will be given a slightly greater inclination with the axis of the shaft, which will immediately cause the length of stroke of the pistons to be increased, thereby causing a proportional increase in the rate of pumping of the fluid. If it is desired to keep the shaft 10 rotating and at the same time to cause the pump to cease pumping, the worm 44 is rotated in a clockwise direction until the adjusting-ring has been brought to a perpendicular position, at which position the pistons will cease to have a reciprocatory motion in their respective cylinders and the action of the pump ceases. If it is desired to cause the pump to draw the fluid through the port through which it previously forced it and force the fluid so drawn into the port through which it previously drew its supply and with the shaft 10 rotating in the same direction as before, the worm-screw would be rotated in a clockwise direction to such an extent as to cause the adjusting-ring to assume an angle on the opposite side of the vertical to that which it previously made, the amount of such inclination being dependent on the rate at which it is desired to pump.

The operation of the device when used as a

motor is as follows: Suppose the parts to be in the positions shown in Fig. 1 and that a source of fluid-pressure supply is connected to the passage 38′ and that a proper receptacle for the exhaust is connected to the passage 38^2. Fluid-pressure will enter through the port 36′ of the valve and thence through the ports 13^2 and 13^3 into their respective cylinders 12^2 and 12^3 and acting against the pistons 14^2 and 14^3 will cause them to press against the thrust-ring 26, which pressure acting on the thrust-ring will cause it to revolve in a counter-clockwise direction as viewed from the right-hand end of Fig. 1, and such rotation being impressed on the thrust-ring 26 will cause the thrust-ring, through its conically-shaped projections intermeshing with the conically-shaped projections of the ring 15 on the cylinders, to drive the cylinders around in the same counter-clockwise direction, and the cylinders being fastened to the shaft 10 will cause the shaft 10 also to revolve in the same direction. As the cylinders pass under the exhaust-port 36^2 their respective pistons would be moving toward the closed ends of the cylinders, thereby causing the fluid in said cylinders to be forced out through the exhaust-port 36^2 into some receptacle provided therefor. In order to cause the motor to cease revolving, it would only be necessary to bring the adjusting-ring into a vertical position, in which position the pistons would cease to reciprocate in their respective cylinders due to the pressure which they exert on the thrust-ring being perpendicular to the direction in which the said thrust-ring is free to move in the adjusting-ring, and consequently they would exert no force to cause the thrust-ring, and thereby the cylinders and shaft, to revolve. In order to cause the shaft 10 to revolve in an opposite direction, the adjusting-ring will be brought to such a position that it makes an angle with the axis opposite to that which it previously made, and since the thrust-ring must also make the same angle with the axis as the adjusting-ring the resultant of pressure of the pistons acting on the thrust-ring through their connecting-rods would cause the thrust-ring to revolve in the opposite direction, which would in turn, through its projections intermeshing with the projections of the ring on the cylinder-drum, cause the drum, and thereby the shaft to which it is connected, to also revolve in a direction opposite to that where the adjusting-ring had an inclination on the opposite side of the vertical.

I claim as my invention—

1. In a pump or motor, the combination with a revoluble shaft mounted in suitable bearings, of a plurality of cylinders provided with ports for the inlet and exhaust of fluid grouped around the shaft, a valve structure having ports adapted to register with the ports of the cylinders, pistons in the cylinders, a ring inclined to the shaft and pivotally supported thereby, a thrust-ring rotatably mounted on the said ring, connecting-rods between the pistons and said thrust-ring, and connections between the thrust-ring and the cylinder structure to cause the cylinders and the thrust-ring to retain their relative positions, substantially as described.

2. In a pump or motor, the combination with a revoluble shaft mounted in suitable bearings, of a plurality of cylinders provided with ports for the inlet and exhaust of fluid grouped around and revolving with the shaft, a stationary valve structure having ports adapted to register with the ports of the cylinders as the latter revolve, pistons in the cylinders, a ring inclined to and relatively fixed with respect to the shaft, but pivotally supported thereby, a thrust-ring rotatably mounted on the said ring, connecting-rods between the pistons and said thrust-ring, and connections between the thrust-ring and the cylinder structure to cause the cylinders and the thrust-ring to turn in unison, substantially as described.

3. In a pump or motor, the combination with a revoluble shaft mounted in suitable bearings, of a plurality of cylinders provided with ports for the inlet and exhaust of fluid grouped around and revolving with the shaft, a stationary valve structure having ports adapted to register with the ports of the cylinders when the latter revolve, pistons in the cylinders, an adjusting-ring inclined to and relatively fixed with respect to the shaft, but pivotally supported thereby, a thrust-ring rotatably mounted in the said adjusting-ring, connecting-rods between the pistons and said thrust-ring, connections between the thrust-ring and cylinder structure to cause them to turn in unison, and means for varying the inclination of the adjusting-ring with respect to the shaft, substantially as described.

4. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings of a drum secured to and revolving with the shaft and having a plurality of cylinders provided with ports for the inlet and exhaust of fluid, a stationary valve structure having an overlapping flange surrounding the end of the drum and provided with ports adapted to register successively with the ports of the cylinders when the latter revolve, means for securing the drum to the shaft and maintaining its closed end out of contact with the face of the valve structure, pistons in the cylinders and connections between the pistons and shaft for causing the same to rotate in unison, substantially as described.

5. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, of a drum secured to the shaft having a plurality of cylinders grouped around the said shaft, a stationary valve structure having an annular flange bearing upon the periphery of the closed end of the drum, means for maintaining the latter out of contact with the face

of the valve structure, coöperating ports in the flange of the valve structure and the cylinders for inlet and exhaust of fluid, a thrust-ring inclined with respect to the shaft and rotatable with the same, pistons in the cylinders and connections between the pistons and thrust-ring, substantially as described.

6. In a rotary reciprocatory pump or motor, the combination with a shaft, cylinders and pistons grouped around and rotating therewith, of an inclined thrust-ring rotatable with the shaft, means for pivotally supporting said ring upon the shaft, connecting-rods between the pistons and ring, intermeshing conically-shaped projections on the cylinder structure and the ring for causing the two to rotate in unison, and conically-shaped sleeves rotatably mounted on the projections and providing a rolling contact between the said intermeshing elements, substantially as described.

7. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, a drum having a plurality of cylinders fixed thereto, pistons in said cylinders, of a relatively fixed adjusting-ring pivotally supported on the shaft but non-rotatable therewith, a thrust-ring supported by the adjusting-ring, connecting-rods between the thrust-ring and the pistons, and means for varying at will the angle of the adjusting-ring with respect to the shaft, substantially as described.

8. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, a drum having a plurality of cylinders fixed to the shaft, pistons in said cylinders, of a relatively fixed adjusting-ring pivotally supported on the shaft but non-rotatable therewith, a thrust-ring supported by the adjusting-ring, connecting-rods between the thrust-ring and the pistons, gear-teeth carried by the adjusting-ring, and a rotatably-mounted engaging element for said teeth capable of movement at will to vary the angle of the adjusting-ring with respect to the shaft, substantially as described.

9. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, a drum having a plurality of cylinders fixed to the shaft, pistons in said cylinders, of a relatively fixed adjusting-ring pivotally supported on the shaft and non-rotatable therewith, a thrust-ring supported by the adjusting-ring, connecting-rods between the thrust-ring and the pistons, a sector worm-gear on the adjusting-ring, and a worm-screw engaging the sector-gear for effecting adjustment of the ring to vary its angle with respect to the shaft, substantially as described.

10. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, a drum having a plurality of cylinders fixed to the shaft, pistons in said cylinders, of a relatively fixed adjusting-ring pivotally supported on the shaft but non-rotatable therewith, a thrust-ring supported by the adjusting-ring, connecting-rods between the thrust-ring and pistons, an extension on the adjusting-ring having a sector-gear, a worm meshing therewith, and guiding-flanges extending from the sector-gear beyond the teeth thereof and adapted to bear against the sides of the worm, substantially as described.

11. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, of a drum fixed to the shaft and having a plurality of cylinders therein, means for admitting and exhausting fluid to and from the cylinders, pistons in the cylinders, and an adjusting-ring having a collar pivotally attached thereto and confined against longitudinal movement on the shaft, and connections between the pistons and adjusting-ring, substantially as described.

12. In a pump or motor, the combination with a shaft rotatably mounted in suitable bearings, of a drum fixed to the shaft and having a plurality of cylinders therein grouped around said shaft, means for admitting and exhausting fluid to and from the cylinders, pistons in said cylinders, an adjusting-ring having a collar pivotally attached thereto and confined against longitudinal movement on the shaft, and means for varying the angle of inclination of the adjusting-ring with respect to the shaft, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES M. MANLY.

Witnesses:
M. H. MILES,
C. W. FOWLER.